MAIN CURRENTS IN MODERN THOUGHT

A monthly service that brings together contemporary data in all fields, as this issues from laboratories, studios, class-rooms, observatories and wherever man pursues the eternally intriguing and beautiful mysteries of Nature

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THE TRIUMPHANT RETURN OF IDEALISM

Editorial Summary

MAIN CURRENTS in Modern Thought assumes with this issue a new dress. Two years of experiment have come to an end, and we are ready now to appear before new friends, through the help and with the encouragement of old friends. The fresh attire is for this gala occasion.

In the circumstances we are impelled to open the new volume from the highest possible vantage ground afforded by contemporary knowledge, whence the main currents in modern thought have their source. From this mount, central and secure, they may be seen streaming away in all directions. This is the reason for the contents of this issue.

That vantage ground is mathematics. It appears so exalted that many people believe themselves unable to attain it. This is not the fact. All that is important in mathematics for right living, can be understood when the developments arrive at the point where they are applicable to daily life, and to attitudes of mind. It is only while the great ideas are gestating that they still belong, like unborn children, to another world. From that, to carry the analogy further, they enter this one, and then we can, with no great effort, understand and use them in daily life and thought.

It is the wonder of these, our very own decades, that the new gains in mathematics have now become viable and tremble on the verge of birth and of usefulness. It is our intent here to indicate in what sense great events impend from that direction. It is the purpose of this issue of MAIN CURRENTS as a whole to convey the very latest news of the developments in question.

It is now widely recognized that in 1905 and especially in 1915, western thought was given by Albert Einstein a remarkable turn through the restoration to high esteem of idealism, that philosophical attitude which maintains that the mental — hence also spiritual and moral — laws discoverable and usable within the individual human mind, are at work on a larger scale in Nature. More modestly put, and in Jefferson's words in the Declaration of Independence, "the laws of nature and of nature's God" turn out to be ideal, primarily. Matter, it appears, is their expression — not their muddy morass. And man, in a small way, has enough mind or soul to perceive these laws, because he is a microcosm in that macrocosm. The importance of Einstein is in the fact that his thought extended idealism to the cosmic scene, sweeping up local achievements such as those of the brothers Bravais (who conquered the domain of the crystals by pure geometric thought), and Mendeleyeff (the author of the geometric paradigm of the elements) and many others. More, he opened the way to make matter itself a function of ideas, instead of leaving ideas — and with them life — in lowly place as a by-product of matter and matter's victim in the end.

All this is of course in the noblest and oldest tradition of philosophy. Our minds run back to Plato and to Shankaracharya for equivalents in antiquity. But now the idealism has a strange new resource not only for the understanding of Nature but for direct power over her. This power is as yet at a low level and on a small scale. It pertains to the making of plastics or to flight and the like. But when idealism extends to biology and to psychology (as genetic mutation in the one case and gestalt closure in the other indicate the ways this can be done) the power will slowly become subtle, moral and superior, because it will include power by man over himself.

Until this latter development comes about it is clear that we have only an idealism without values, which can substitute a subtle energetics in place of a crass materialism which it has destroyed and supplants, but does not by itself ensure the triumph of ethics. But when the next great turn is given to this idealism, by discovering how life and consciousness fit into the new ideal picture, the true gains may at last be possessed.

One of the principal purposes of MAIN CURRENTS is to report on and help to extend the new re-conquest of the ideal realm. The remainder of the present editorial summary will be devoted therefore to reviewing important elements from the material sciences and mathematics which have entered in to create the new situation; and to suggestions as to bearings on biology and psychology, and upon attitudes and conduct.

The developments actually started in mathematics. Up to the beginning of the nineteenth century nothing very new had appeared in geometry, which was still much as Euclid had left it and much as we all learned it in school. In the first quarter of that century a great rebel appeared, Bolyai Janos. He questioned the statement (now called Playfair's axiom) that only one line can be drawn parallel to a given line through a point outside that line, and he constructed a self-consistent geometry in which any number of lines can be drawn parallel through that one point. Such a notion is not nonsense for the excellent reason that Euclid's own statement involves infinity — and what infinity may really be no one can yet say. As regards a limited length of line Euclid may be right, for there are two end points. But as regards a line of infinite length, the matter is not susceptible to

proof. It may be challenged for the reason that infinity has a variety of properties. Infinity, as against finite or phenomenal, is capable of entering directly into all events, structures and lives. It is absolute and survives the death of the cosmos. Indeed, if there be any truly universal God this is it, as Albert Einstein told the first meeting of the Conference on Religion, Science and Philosophy in 1940. If there be any ground on which religion and science are to meet and get the help of philosophy and art, this — the infinite — alone is such ground. Hence Bolyai must be regarded, and history has proved him to be, not irrational, but supra-rational. Once this is seen, these events become urgent, practical, and bear ethical import.

With Bolyai and after him appeared a series of thinkers in geometry—Lobatchevsky, Gauss, Riemann, Cayley, Felix Klein, Sophus Lie — who have established slowly the fact that in a universe such as ours, with free movement of figures in space in the infinite sense, four kinds of three dimensional space, and four only, are possible; a sort of absolute Quaternary. Among these geometries one of two introduced by Riemann is uniquely important.

Meantime physics had been going through profound change also. This is a familiar theme and needs little recounting. Commencing in a crucial way with Rutherford and J. J. Thomson it has become finally sure that matter is not close-packed solid atoms, but an electronic mist so fine that in something apparently as solid as a cubic crystal of lead the space content is many thousands of parts to one of electronic atoms. In fact the "lead" is virtually infinitesimal and the space is virtually infinite. Thus the concept of atoms began to approach points in space — always in infinite space — and the question of the nature of that space could not be put aside.

This became especially evident when certain celebrated men in physics attacked the problem left in their hands by astronomers, particularly Newton. When Newton came to discuss how planets acted on each other at a distance he suggested that there might be some medium within which planets swung. He must be acquitted of having said so explicitly, but gradually it became assumed that some such medium must exist. When presently it became clear that this spacelike medium was the major content of solid bodies, and that light along with other electromagnetic phenomena occurred in this ether, the hope arose of experimenting directly upon it. Oliver Lodge was one of the early workers on this problem, but Michelson and Morley are the most celebrated and decisive names here. No experimental methods could however be devised to show that the ether had any relation to matter. Did it therefore exist at all?

This is why Einstein finally suggested boldly (in 1905) that the ether be ignored. He proposed that it should be assumed that gravity in itself (the gravitational potential) is not measurable by any ordinary means whatsoever, in physics directly. He no more said ether does not exist than Newton said it did. In fact, by taking the velocity of light as a constant property there is a concession in principle that there may be a state of affairs such as was implied by the concept of ether. Einstein's purpose was practical, though his instrument was pure mathematical speculation. The object was to explain all manner of physical goings on, including gravity, by examining the properties of space in itself. It is this, with the aid of Minkowski and others, which proceeded from 1905 to 1915, when the results were generalised and the new turn in thought was finally definitely made. Europe was, so to speak, round the corner.

Meantime a very interesting and important development was proceeding. The space that was to be examined was not ordinary workaday waking three-dimensional space, but a four dimensional variety, with time as the fourth dimension. This is a very old idea, probably first put into words in recent European history by D'Alembert. But now, thanks to the non-Euclidean geometers, to the physicists and the new school of Relativists it was no longer an idea only. It became quite necessary to find out about this fourth dimension and to examine its properties — which are extremely illuminating and curious, not hard to understand if one is interested; and endlessly fascinating.

Many workers at once converged upon it, and continued until at last standard textbooks have been written. The subject is far from exhausted, however, for the fourth dimension may be treated by any one of the four geometries above mentioned (first, Euclidean; second, that of Bolyai-Lobatchevsky-Gauss or hyperbolic; third, Riemannian spherical; and last, Riemannian elliptical geometry). It is no more certain which one obtains therein than rules here in ordinary waking experience. On the whole however the tendency today is to regard the fourth dimension, could it be experienced, as being elliptical — the last above mentioned.

Two very important matters are thus before us as a result of this revolution. First, idealism is now established not as a weak philosophy, a goal toward which we vainly strive, but idealism as causal and (oddly enough!) real. The unsubstantial, that is to say, provides the properties and the farthest reaching rules for the goings-on in the substantial.

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The second matter of importance is what most concerns us here. Many properties of space-time or the fourth dimension were left over from the studies of the geometers, and not used by the physicists and astronomers. (We speak only of so-far established standard properties such as are expounded in a text like that of H. P. Manning.) They pertain mainly to the Euclidean properties of a fourth dimension. Briefly, quoting from an extensive survey of the subject done by the present writer, it appears that there are seven and only seven regular Forms, in space-time taken as the fourth dimension. These Forms are called polyhedra in three and polytopes in four dimensions. In three dimensions there are six and in four dimensions seven of them. Two of the polytopes, having as their analogies the familiar cube and simple octahedron, give rise to all the crystals known in Nature or made in the laboratory. This is quite clear from the work of Pieter Schoute, Alicia Boole Stott and others.

Two more having as their analogues two other well known regular polyhedra, the dodecahedron and the icosahedron, appear to be the Forms which govern the morphology of plants. This proposal is new, but available data supports it — such items as leaf-arrangement studied by Goethe, Schlimper, Braun and most of all

Church at Cambridge. Plants being the lowest sentients, the same data as provided by Church of leaf arrangement under a natural logarithm, brings in the Weber-Fechner law of psychic response, also a logarithm curve. Why there is a grand division of plants into monocotyledons, dicotyledons and a third group difficult to describe as regards cotyledons, but clearly marked off from the other two, begins to be explicable. All this is bound together because growth is a special kind of function of time, and goes on in time in an orderly way. (Since this proposal is novel, much of the reason comes as yet from aesthetic sources, such as dynamic symmetry, the well known discovery of the late J. Hambidge.)

Continuing our series, we come upon a strange Form in the fourth dimension which has no true three dimensional analogue — as the others above-mentioned have. But its features are known, and they fit smoothly into the properties of animal forms. Thus point symmetry in many crystals, and linear (axial or stem) symmetry in plants overwhelmingly, and then bilateral or plane symmetry in animals, can be explained with this data, which throw strong light on the fascinating studies in D'Arcy Thompson's book, *Of Growth and Form.*

Finally, we have left man, the last of the Kingdoms in Nature; and the sphere, the last of the regular Forms. When we consider these Forms a host of simple unifications of known data flood the mind. Most conspicuous of all is the fact that spherical harmonics, a high human attainment, is the mathematics which describes not only music, but the flow of heat and of electricity. We are back at the threshold of Riemannian space-time. Our excursion has brought us to Man, the point of consciousness in the infinite sphere; Man, the Monad of Leibnitz, in the world of the absolute; Man, the Atman of the Hindu thinkers.

Extended discussion of this aspect of the new idealism — namely, the relation of the geometry of hyperspace to living creatures (biology) and to man (psychology) must be set over for another occasion. It is mentioned here only to show that studies of this character have been pursued and a prima facie case sufficiently well established to enable us to say that matter is not the only great category in the cosmos which is a projection of Ideas. Life and living forms also come from ideas. So also is man caught up in a web of ideal forces, and it is of the utmost importance in our time that the reality of this situation for man be appreciated, and the ethical outworkings be seen, so that new social and economic turnings can be wisely made.

The direct application of mathematical knowledge expressed as material technichology tends to make for mankind quite as much trouble as it makes peace. The new idealism provides an opening for the creation of ethical norms to correct those evils—ethical norms which can be validated by the same mathematics which is behind the technologies. But the ethical implications can only come when the mathematical procedure is proved to be behind not only matter, but life and consciousness as well. Many great minds have suspected, perhaps even known this by special insight. But now we are ready to prove the fact by the very same methods as obtain in the most exalted astrophysical and the most refined electronic fine-world investigations. We shall not have to rest then upon our intuitions alone to tell us that Buddha, Jesus, Plato, Leibnitz, Spinoza and others were right. The force of moral law will be known to be operating as universally as does the law behind gravity and electricity — indeed, it will be seen to be the same law — and mankind can be brought at last to know that escape from law is impossible, and therefore that ethical conduct is as rational as the heart tells us it is good. Knowing what ethical law is, it can be obeyed wisely, and the mind can join the heart.

Thus has run recently the strange course of European thought. Thus in 1942 we stand on the threshold of a grand orchestration of all knowledge, even as the world is struggling toward a physical unity. We are therefore honored to print in this present issue (p. 4) an original article by Prof. Cornelius Lanczos, putting into straightforward language the theme of his announcement published in the Physical Review, June of this same year (Vol. 61, Nos. 11 and 12) and a reprint of Dr. Archibald Henderson's unique geometrical explication of the Einstein discoveries (p. 9).

F.K.

UNIQUE PROJECT

Mathematics by the Million

In Science, September 25, 1942, Raymond Clare Archibald of Brown University writes an interesting account of the Mathematical Tables Project of the WPA. This is sponsored by the National Bureau of Standards, Dr. Lyman J. Briggs, Director, and under the Technical supervision of Dr. Arnold N. Lowan. At present the project is heavily engaged in war work, but continues other work. The point of interest to readers of Main Currents is that here is a government project doing a task which is of the highest value for the whole of the cultured world. The computation by thousands of pages of tables of complex functions such as those of Bessel and Legendre and others, has an important place in the eventual unification of world-theory, in addition to providing a host of practical data for various applications in scientific work.

The magnitude of the job may be judged from Dr. Archibald's description: "In that extraordinary laboratory at 70 Columbus Avenue in New York City, there are now 250 computers working in two shifts from 9:00 o'clock A.M. to 5:00 P.M., and from 5:00 P.M. till midnight, on five days of the week. The two shifts are necessary in order fully to utilize the 150 machines provided for the work."

DYNAMIC RELATIVITY, by Cornelius Lanczos

An Original Article

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ONE of the most outstanding thoughts of the natural philosophy of the Greeks was the a priori conviction that nature is reasonable and open to logical analysis. In contrast to the mystical philosophy of Christianity, Greek thought favored a metaphysical but rational approach to the laws of nature. The Greek philosophers saw just as clearly as any modern scientist that the changeable and accidental world of sense impressions is a mere reflection of a deeper and everlasting world of reality, which cannot be grasped by our senses but which can be approached with ever-increasing clarity by the thinking mind. The pure and divine science of geometry was the eternal pattern on which all theories about nature were modeled. Plato expressed strikingly the metaphysical rationalism of Greek philosophical yearning when, asked about the occupation of the divine mind, he gave the answer: "God always geometrizes."

Modern experimental science, founded by Leonardo and Galileo, denied the legitimacy of a priori thinking. Any contemplation of the laws of nature has to be based strictly on experiments and must not go beyond the realm of experiments. Yet those very experiments have shown that there are all-embracing laws in nature, and the speculative human mind has never abandoned the hope that some day the basic draft of the universe will be laid open to its intellectual eyes.

Einstein's theory of relativity gave a mighty impetus to a new era of world-building theories. If the Greek mind had hammered at a problem which it was unable to solve because of the lack of adequate tools, two thousand years of cautious mathematical development had slowly prepared those tools; and suddenly the human mind found itself once more at the very gates before which it had stood two thousand years before. The abstract language of mathematics provided that "open sesame" that Greek philosophy instinctively presaged. Einstein's speculative genius has shown that the a priori conviction of the Greek philosophers concerning the reasonableness of nature was indeed no idle dream. Philosophical speculation, guided by the mighty tools of higher mathematics, could penetrate into depths that no experimental research could ever hope to reach. Moreover, if the Greek mind worshipped geometry as the most perfect of all sciences, Einstein's theory fully justified that preinclination by showing that the law of gravity is a purely geometrical law, being an emanation of the specific geometrical structure of the universe, a geometrical structure called "Riemannian" ("ie" as "ee") because the laws of this geometry were laid down sixty years earlier by the ingenious mathematician Riemann.

Einstein's immortal discovery linked geometry and physics together, and the thought then became inevitable that one day *all* physical action may be resolvable into a geometrical pattern, thus uniting geometry and physics into one inseparable science: "God always geometrizes" became the very slogan of modern speculative research.

The principal achievements of the Einsteinian theory of relativity can be condensed in the following three points:

1. "Space and time belong together and form one inseparable unity. Hence geometry includes time as the fourth dimension. The geometry of nature is not a three-dimensional but a four-dimensional geometry."

2. "There are no preferred reference systems in nature. All reference systems must be equally good in describing the laws of nature."

The basic quantities of nature are not pure numbers but are of a *directed* type. Take force, for example. It has magnitude *and direction*. For the analysis of such quantities — generally called tensors, — we are forced to employ a definite frame of reference. For example, we may set up three mutually perpendicular axes and analyze the force relative to that reference system. But a reference system is never more than a scaffold and should have no more rights than a scaffold. There should be no "absolute" reference systems in nature: one system has to be just as good as another. The principle of general relativity is actually the principle of general democracy for nature. All possible frames of reference must be admissible as equally justified. Here we have a scientific formulation of the famous phrase of the American Constitution: "All men are created equal."

3. "The geometry of nature is not of the ordinary Euclidean but of the Riemannian type. This means that space is not flat as the older geometry assumed it, but has a curvature which changes from point to point. One can picture the world as an almost flat country with occasional high mountains growing out rrom the plane. These mountains represent the electrons and other basic particles which form the 'matter' of physics."

Riemann has shown that his geometry can be characterized by a fundamental tensor, called the curvature tensor. This curvature tensor is a very complicated mathematical quantity. We can think of the curvature of a surface as one quantity, but in three or four dimensions the curvature has not only magnitude but direction. It requires a reference system to analyze it. In four dimensions the curvature of Riemann can be characterized by twenty different components.

Einstein succeeded in simplifying the curvature tensor of Riemann. The curvature tensor of Einstein has only ten instead of twenty components. This new tensor can be directly associated with a purely physical quantity called the matter tensor. It is the quantity which includes all the physical actions of matter. Einstein made the immortal discovery that a purely geometrical and a purely physical quantity are actually one and the same. The same quantity can be called "curvature tensor" if we use the language of geometry, and "matter tensor" if we use the language of physics. Physics and geometry are merged into one science. We can interpret matter in curvature terms, just as we can interpret curvature in physical terms. This is the great discovery of Einstein, which required a power of abstraction and a far-flung imagination that has no parallel in the entire history of science.

Now, in empty space which is free of matter, the matter tensor vanishes and hence the Einsteinian curvature tensor vanishes also. The corresponding mathematical equations are Einstein's famous gravitational equations, found in 1915. They give a perfect explanation of the mysterious phenomenon of gravity in purely geometrical terms, allowing derivation of the equations of Newton without making up a properly constructed "force of gravity." Gravity is not caused by any force, but it is caused by the Riemannian structure of the four-dimensional world.

However, matter certainly can not vanish everywhere. If the matter tensor vanished everywhere, we would obtain the uniformly flat space of Euclid. No physical action of any kind could take place and the world would be free of matter. We know that this is not the case. But then the question comes up: "What happens in those parts of space in which the matter tensor does *not* vanish?" What announcement shall take the place of the too simple announcement that the curvature tensor is zero? The theory must be able to explain why it is that matter is concentrated in small lumps of high-density — the elementary particles which form matter — and not spread out uniformly over space. Why is the matter tensor *generally* zero but not *everywhere* zero?

Various more or less promising answers were given to these questions. They all have the property that they abandon one or the other feature of the original theory. Some of them sacrifice the Riemannian geometry in favor of a still more general geometry. Some others claim that the world is actually not four- but five-dimensional and that the fifth dimension corresponds to electricity.

The author's own solution is characterized by the fact that neither the Riemannian nor the four-dimensional basis is abandoned. No strange hypotheses of any kind are necessary. Nothing is put into the basic assumptions which will anticipate the results we want to obtain. And yet the fundamental laws of electricity and a peculiar interaction between matter waves and electricity can be deduced from the basic equations as necessary mathematical consequences.

We can assume that the statement "the curvature tensor vanishes" has to be replaced by some other more general statement concerning the same curvature tensor. This announcement must take the form of equations, called "field equations." Since we have an assembly of ten quantities, we must get ten equations. Moreover, we know from the principle of relativity that these equations must hold equally in any arbitrary reference systems. How can we arrive at such equations as these?

The only reasonable principle we know for the derivation of such equations is the "principle of least action." This principle assumes that there is a certain quantity in nature, called "action," which tends to become as small as possible. This principle was originally established for pure motion phenomena, but it has gradually grown to absorb all phenomena of nature. All equations of physics, including the equations of modern atomic physics, seem to satisfy this principle. While in the older days this principle was interpreted as a proof of the wisdom of the Creator in achieving His aims with the smallest possible efforts, we are inclined to interpret the principle in less personal terms. We see the importance of this principle primarily in the fact that it allows the derivation of an arbitrary number of equations from one single announcement. The principle has thus an all-embracing character. Moreover, the principle depends on one single quantity, the "action." If only the action is given, the rest is pure mathematical calculation.

Now, applying this principle to the derivation of the basic field equations, we know in advance a few things. We know that the action can not depend on any special reference system. It must be what we call an invariant, which means a quantity that has the same value in all possible reference systems. Furthermore, it must be formed out of the components of the curvature components, — not necessarily the Einsteinian curvature tensor, but that more general curvature tensor that Riemann recognized as the basic quantity of his geometry. The Einsteinian tensor is a simplified version of that tensor and we must be able to explain why, for the actual world, that simplification takes place.

In view of these circumstances we have a priori *five* possible quantities with which we can experiment. This "embarras de richesse" is quite distressing. Fortunately, however, two of these invariants happen to be inactive — they do not contribute anything to the field equations and thus can be dropped. The third is reducible to the remaining two invariants. And thus the uncertainty is remarkably reduced. We have finally just *two* basic quantities from which the action can be formed. It is most remarkable that both of these invariants are formed with the simplified Einsteinian tensor and not the general tensor of Riemann. This is very promising because the general tensor of Riemann seems to be void of any natural physical interpretation.

Hence the fundamental action quantity is now tracked down to a combination of two basic invariants. They are tied together by a numerical factor which is a pure number. The uncertainty of the actual value of this number was still a serious handicap in the earlier phases of the theory. One value seemed to be just as good as another. The uncertainty of this number was one of the principal difficulties which hampered all further progress in the beginning.

After ten years of unsuccessful contemplation the author finally noticed that one particular value of the undetermined factor — it happens to be the number minus one-fourth — is distinguished by particularly desirable qualities. It was the only number which led automatically to an explanation of the atomistic structure of matter. The last uncertainty was thus removed and the universal action principle of the world became completely and uniquely determined.

This pinning down of the action principle to one completely determined function is of no small interest. It provides the solution of one of the most difficult problems, which has always baffled all attempts toward a truly unified general field theory. This is the existence of atomism in the world. We can hardly doubt that any possible explanation of this phenomenon must be based on the assumption that somehow there exists a natural gauge in nature for the measurement of lengths. This gauge is much smaller than our "inch" in which we are

accustomed to measure lengths. The natural gauge of nature must be of atomistic dimensions, i.e., of the order of one billionth of an inch. How can one account for the existence of such a gauge? To be sure, it is not the smallness of the gauge which constitutes the problem. That the world of atoms and molecules is very small in comparison to our ordinary human needs is purely a matter of biological evolution and of no general concern. But why should nature *prefer* any definite gauge? To assume that such a gauge should enter the basic equations is excessively improbable because one can not give any plausible reason why one length should be preferable to any other length. This would violate the democratic principle of nature just as badly as the preference of one distinguished reference system.

The apparent contradiction exists only so long as we do not distinguish between *potentiality* and *actuality*. *Potentially* one length must be just as good as another. But there is no objection that *actually* a definite gauge shall exist in the world. The fundamental laws of nature can not contain a definite length. But in the *actual solution* of those equations such a length may appear. Now it so happens that the choice of minus one-fourth of the originally undetermined numerical factor actually provides a natural gauge.

Interestingly enough, this solution is identical with equations that Einstein proposed many years ago for the explanation of certain astronomical facts concerning the structure of the world *in the large*. We have good reason to assume that space does not extend into infinity but is a kind of finite receptacle. If one continues to travel permanently in the same direction, one eventually comes back from the other side to the point from which one started, just as one can circumnavigate the earth, which is likewise a closed finite surface, although at the dawn of civilization people thought it flat. To discover that the entire space too is of a closed structure naturally required a much longer evolution.

But to circumnavigate the entire universe would certainly take millions of years, even if we travelled with the greatest possible speed, which is light velocity. The radius of the universe is thus excessively large; it goes into millions of trillions of miles.

Peculiarly enough, the same equations which have been evoked to explain the structure of the universe in cosmical dimensions, are now evoked to explain the structure of the universe in *atomistic* dimensions. The same radius which measured the curvature, in millions of trillions of miles, now suddenly shrinks to dimensions of one fraction of one billionth of an inch. This metamorphosis is paradoxical enough and yet it makes good sense if one interprets it in the proper way. It does not mean that the whole world is reduced to the dimensions of an atom. We have to see the problem in a different light.

Earlier we have compared the world with a generally flat plane on which high mountains are erected. This was the picture of a generally empty space, occasionally interrupted by the material particles which occupy but very small portions of the space. Now let us imagine that we take a powerful microscope with which we examine the surface of the plane more carefully. We discover that our basic surface is actually not a smooth plane. A layer of very fine sand grains is spread over it. Each one of these sand grains has a high curvature; and if we determine the average curvature of our plane, we find a very high value, — the higher, the smaller the sand grains become. And yet, if we walk over the surface with our big boots, we think that we walk over perfectly flat land, with the curvature zero. This picture explains how the average curvature of the world can be excessively large and the world still remain just as extended as it has been before. The exceedingly fine "sand grains" of that apparent plane cause the high average curvature.

These fine sand grains do not show up under ordinary circumstances because the ordinary masses are like steamrollers in comparison to them. In the case of very light masses, however, the road on which they travel becomes bumpy and causes deviations from the straight path. We encounter such "uncertainty phenomena" in the well-known matter-wave experiments of wave mechanics.

This "sandy" structure of the background of the world now provides an excessively high instead of excessively low average curvature, and we obtain that natural gauge of very small dimensions which makes atomism possible. But more than that can be said. The change from a smooth to a sandy background represents the appearance of a radically new element in Einstein's theory of relativity. Einstein's theory of gravity was based on the assumption that the world is almost in equilibrium and only a little action is going on in it. The new theory claims that the world is permanently in a state of high agitation. The *static equilibrium is changed to a dynamic equilibrium*. The "cosmic sand" which is spread all over the world is actually an incessant *radiation* which goes on without beginning and without end.

This new dynamic interpretation of the world suddenly solved one of the inexplicable riddles which had punctured all the earlier advancements of the author. The first draft of the theory ten years ago was able to show that the new action principle provides a natural interpretation of the phenomenon of electricity. Electricity is deeply connected with one of the basic features of Riemannian geometry, the "conservation law of energy and momentum."

We know that nature watches anxiously over the budget of certain quantities and does not permit the slightest change of the total amount. Energy can be transplaced from one point to another but the total amount remains always the same. No creation or destruction of energy is ever possible. The same is true of momentum. Relativity has shown that these two quantities form one inseparable unity; the one is impossible without the other. The conservation of energy and momentum is thus actually *one law*; we merely observe that law in two different forms.

This fundamental conservation law of energy and momentum is a natural mathematical property of that curvature tensor that Einstein interpreted physically as the "matter tensor." In fact, it is exactly the conservation law which makes the identification possible. This law is no longer some basis postulate of nature, established in order to preserve something. It is an inevitable mathematical consequence of the Riemannian structure of the universe.

The mathematical investigation of the new action principle has shown that the very same property of

Riemannian geometry causes the appearance of electricity, deduced as a necessary mathematical consequence. The basic equations of electricity could be interpreted as a necessary outcome of the conservation laws.

This beautiful result was marred, however, by one serious difficulty. The theory led to the consequence that a free electric charge represents a constant flow of energy. But that would mean that the maintenance of an electric charge requires continuous destruction or creation of energy. This would have to show up in the steady self-destruction or accumulation of mass which is in contradiction to the observed stability of mass. And thus the theory was unable to explain the existence of free electric charges.

However, the difficulty exists only as long as we adhere to that "static" interpretation which assumes that the activity in the world is small. The dynamic hypothesis changes the scenery entirely. Matter is now associated with continuous, everlasting vibrations. These "matter waves" are emanated incessantly and their maintenance requires some source of energy. The same difficulty arises as in the case of the electric charge. *But now these two phenomena together just balance each other.* The mass is not destroyed by the matter waves because the energy flux created by the electric charge compensates for the loss, incessantly bringing in the necessary energy. Similarly, if the matter waves happen to be going in, instead of coming out, the accumulation of mass is avoided by the simultaneous flux of the connected electric charge, which now *carries away*, instead of bringing in, the energy. This simply means a change in the sign of the charge from plus to minus (or vice versa) and we know that indeed both types of charges are present in nature. Electricity and matter waves are thus in a very close interrelation with each other. *Electricity is a necessary accompaniment of the matter waves, its role being to balance the otherwise unbalanced momentum and energy equation.* The electric charge is a good gauge for the amount of incessant agitation going on in nature. In a static world the electric charge would vanish. But we know that the electric forces are overwhelmingly stronger than the gravitational forces. This shows that the dynamic agitation in the world is not small but very high.

It is thus shown that an a priori theory, built on purely logical grounds, based on an action principle which is uniquely determined by mathematical speculations, is able to provide from one unified basis all the fundamental physical phenomena of nature: gravity, electricity, and the wave structure of matter, as necessary mathematical consequences.

The author is well aware that this theory is in sharp contrast to the current views of contemporary physics. According to the current interpretations of Heisenberg's "Uncertainty Principle," any consistent field theory which is based on the fundamental assumptions of continuity and causality is necessarily doomed to failure. According to modern physics, the reason of nature and human reasoning are incommensurable quantities. The basic laws of the universe follow a strange pattern that we have to accept for granted without trying to interpret. Our theories have to follow cautiously the wake of the experiments. We have no right to look for all-embracing universal laws, deduced from logical speculations.

Never the less, the author believes that his new theory provides a new and decisive advance in the field of fundamental research. Standing on the same platform as Einstein's general relativity, not abandoning any of the basic features of the original gravitational theory, a new action principle is established which embraces in the most harmonious manner all the fundamental aspects of nature; namely, gravity, electricity, and the wave structure of matter.

The author has little doubt that the current beliefs of contemporary physics are not more than a transitory stage in the eternal evolution of science. He is convinced that the newly discovered theory will share the fate of so many other scientific discoveries for which the sarcastic but wise word of Schopenhauer holds: "A scientific truth goes through three phases of development. In the first phase it is rejected as absurd. In the second phase it is claimed to be nothing new. In the third phase it is accepted as self-evident."

A FLUID COSMOS

Dr. Birkhoff's View

AT THE Inter-American Astrophysical Congress, Puebla, Mexico, February 20, 1942, Dr. George Birkhoff, head of the Department of Mathematics, Harvard, described in popular language the central idea in a paper he presented. The reader of reports on the interpretations of Relativity will notice how rapidly the great theme is coming within reach of general usefulness, and also how wide is the integration being achieved, including even notions of something resembling Newtonian ether. Dr. Birkhoff is thus reported in the New York Times, February 21, 1942:

"Physicists and astronomers have paid little attention to exploring the possibilities of either theory of relativity with the thoroughness which these theories deserve, but have devoted themselves almost exclusively to quantum physics, in which the notion of time plays a very obscure role. The primary aim of my paper was to show a result that I had not anticipated—that an alternative theory of gravitation explaining the observed phenomena equally well could be based upon the space-time background of the special theory of relativity. My theory may be characterized as follows:

"Instead of using a type of matter with a perfectly arbitrary 'equation of state,' I deal exclusively with what I call the perfect fluid. This fluid is characterized by the fact that the pressure is one-half the density, and was introduced by me in 1928 as the only type of fluid suitable to the requirement of the special theory of relativity. For any other type of fluid or nebulous dust the disturbance velocity is not that of light, and this fact would presuppose a fluid physically impossible of realization and incongruous with the special theory.

"Starting with this fluid and constructing a gravitational potential and gravitational forces in the simplest possible manner, I found that not only were the large-scale gravitational effects in agreement with observations

but that essentially the same formulae were obtained as in the three classical tests of the generalized theory of Einstein. The new theory requires further consideration and seems to me to promise an alternative and simpler theory of gravitation. It is unlikely that any one theory formulated now will hold a final, permanent position. This must be regarded as a sketch of a small part of the grandiose reality."

UNDERSTANDING RELATIVITY

Editorial Comment

Relativity, in the modern sense, is the philosophy which forms a mathematical bridge between absolute realms, with unchanging qualities or properties, and the manifested or phenomenal world. This manifested world, as we all know, shows a variety of changing qualities and properties — growing things, objects in motion and other phenomena.

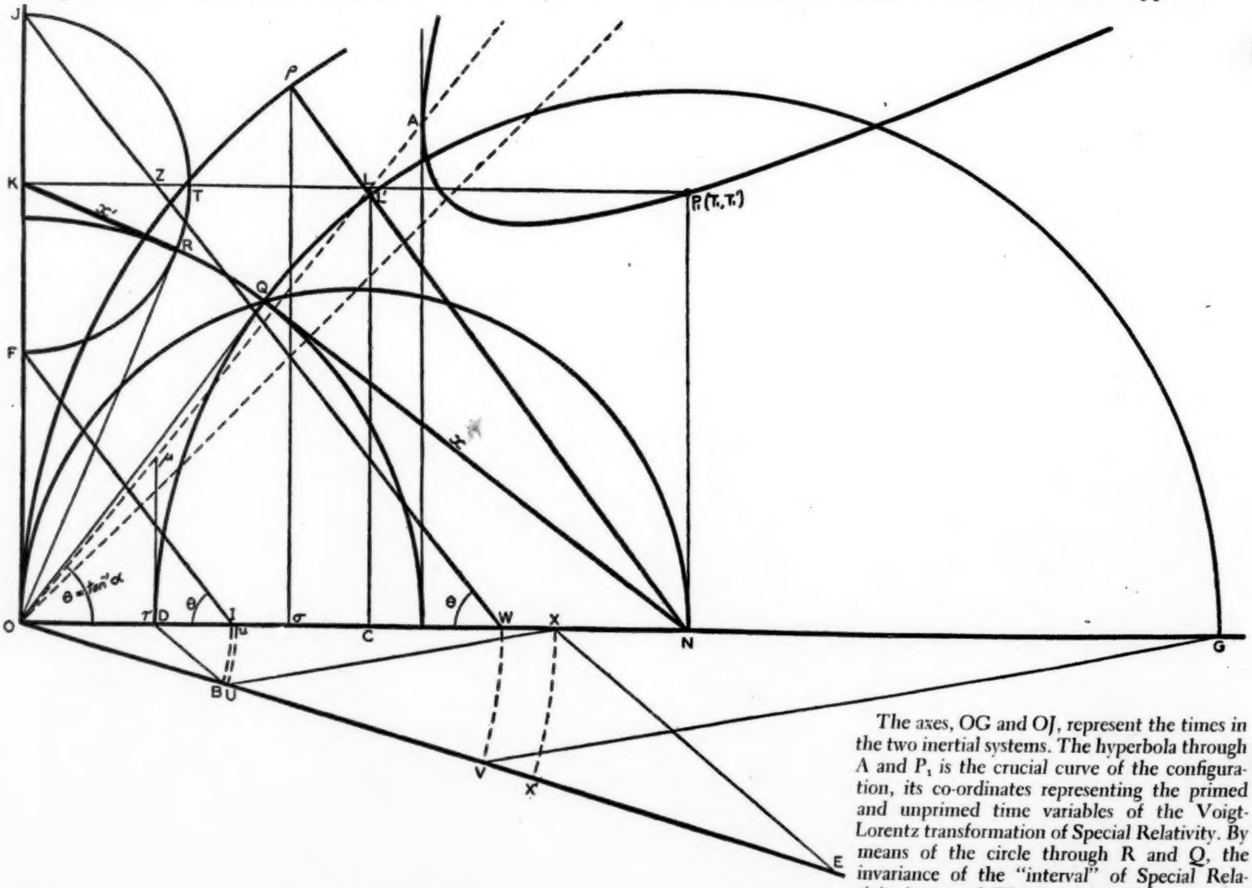
The beautiful feature of the modern view is that the two worlds are linked together on a basis of equality. That is, we are not compelled to believe one world of ideas and of sensory experience, to be the superior or the inferior of the other. They are both taken as part or aspects of a common reality. And the mathematical bridge between them is coming within reach of reason. It is true that in practice the mathematics is still so difficult that the knowledge of how the two worlds are interrelated is as much beyond ordinary reach today as complete mystical experience is outside ordinary range.

But Relativity will come within reach of more and more people. In a few years — assuming we have a proper educational system after the war — Relativity will be in high school curricula, in outline form. Even today the Special Theory has been brought within reach of college sophomore mathematical students through a novel explication of it by Dr. Archibald Henderson, who is head of the department of mathematics at the University of North Carolina.

Dr. Henderson has provided a visual or cartographical accessory in his *New Geometrical Interpretation of Einstein's Special Relativity Theory* and has kindly supplied MAIN CURRENTS with a description of this exposition in terms free of equations.

It deals with the simpler original aspect of Relativity, in which the velocities are constant, not the later generalization in which acceleration (increasing and decreasing speed) is also accounted for. Both these cases involve the peculiar theory that bodies moving at high velocities shorten in the direction of the movement (Fitzgerald contraction). The need therefore arises to set up standards which are good in systems moving at different speeds and provide measurements which agree (Voigt-Lorentz transformation).

As the kind of speeds involved in actual cases dealt with in celestial mechanics are such as to have appreci-



The axes, OG and OJ, represent the times in the two inertial systems. The hyperbola through A and P_1 is the crucial curve of the configuration, its co-ordinates representing the primed and unprimed time variables of the Voigt-Lorentz transformation of Special Relativity. By means of the circle through R and Q, the invariance of the "interval" of Special Relativity is secured. The space co-ordinates, x, x^1 of the Voigt-Lorentz transformation are represented by NQ, KR.

able effect, and as in the heavens bodies are all in relative motion, it follows that Relativity is a practical art. Of course in ordinary terrestrial speeds the effects are not measurable. Therefore Dr. Henderson has introduced slow-motion time with which the curves and straight lines which describe the motions in question can be brought into one diagram.

The motion is slowed 186 thousand times ordinary time. It is easy to show action thus in motion pictures, and the effects are startling, as we all know. It reveals a sort of dream world. When the reverse is brought about, as in the acceleration of plant growth twenty thousand times through stop-action photography, another dream-world phenomenon is seen. The plants act much as animals do, allowing for their anchorage in one place. An odd fact in this connection, however, in the only instance of the equivalent speeding up of motion through space known to the writer, was done by stop-action photography to produce the illusion of falling freely through space. In this case no element of dream quality appears—which is possibly of great interest and importance psychologically.

From all this there seems reason to believe that plants, animals and mankind are differently adjusted to time. Certainly plants in general grow and are not mobile; animals are. Mankind has the additional property of a sense of duration through continuity of consciousness. Let us suppose now, that consciousness is indeed a point, as Leibnitz suggests. Man, in that case, is equipped, as no other creature is, to exist in any and all spaces and times — since the one feature which remains unchanged in all of geometry is the point, whatever may happen to other structures. The point, too, alone could be immortal, since entities which have parts eventually come apart, as the Nyaya-Vaishesika reasoning of India (Hindu realism) so long ago pointed out. Along these lines we see hints of the meanings involved for future generations in Relativity — ethical, and religious meanings, meanings bringing East and West together, drawing mystics of antiquity near to mathematicians of today. F.K.

RELATIVITY MADE VISUAL

Dr. Archibald Henderson

Head of Dept. of Mathematics, University of North Carolina

Because of its difficult and paradoxical character, Relativity is at present a post-graduate study, being available to those students who have taken a collegiate degree, such as Bachelor of Arts or Bachelor of Science.

With the aid of the new geometrical interpretation, a student by the Winter quarter of the sophomore year can be taught Einstein's Special Relativity Theory.

This is an enormous scientific advance, from the pedagogical standpoint; and is destined to give new stimulus to the study of the theories associated with the names of Einstein, the propounder of Relativity, and of his disciples: Poincaré, Minkowski, Eddington, Weil, De Sitter, Lorentz, and the new school of cosmic relativists.

In the present paper, it is assumed that the reader will exercise his intellect actively. The writer does not claim that he can make the reader understand the subject, unless the reader cooperates to the full extent of his reasoning powers. Furthermore, certain things must be assumed, that is, accepted as being true; for the long chain of experiments, involving elaborate scientific arguments and extending over approximately a century of time, cannot be exhibited here, owing to the exigency of space.

Furthermore, it will be necessary to understand one concept which is known as an "inertial system." A simple example is two trains running on parallel tracks each with uniform but different velocities. To clarify the ideas, the reader may think of the two trains as running in the same direction, one at the uniform velocity of 40 miles per hour and the other at the rate of 60 miles per hour. These two trains constitute an inertial system. Please keep this in mind, throughout the course of this article.

II

The experiments we shall consider will be understood to take place either in a laboratory or outside in the open air but they are confined to the Earth itself. We shall exclude consideration of objects in the inter-stellar spaces; for once we begin to include the other planets, stars, etc., we invoke the subject of Generalized Relativity which deals with accelerated bodies. All our experiments, made on an earth which for our purposes might as well be motionless, leave out of account the law of universal gravitation.

You have heard, no doubt, of the Michelson-Morley Experiment. This was first conducted by the late A. A. Michelson, the famous physicist, in 1887; and he carried out the same experiment, later on, with the assistance of E. W. Morley.

Shortly before his death, Michelson carried on a series of elaborate experiments, in the effort to determine the velocity of light in empty space. The result, announced after his death, was that light in empty space travels at the rate of one hundred and eighty-six thousand, two hundred and seventy, and three-quarter miles per second. We shall, for convenience's sake, use the approximate figure, 186,000 miles per second, for the velocity of light in the present discussion.

As the logical and most reasonable conclusions to be drawn from the Michelson-Morley Experiment and other experiments and objections, Einstein in 1905 formulated his Special Relativity Theory in the following form:

1. First Relativity Principle: The velocity of light in free space (i.e. *in a vacuum*) appears the same to all observers, regardless of the relative motion of the source of light and of the observer.

This means that, using the watches and yardsticks at our disposal, the velocity of light always turns out to be 186,000 miles per second. This is equally true if a light ray from a stationary arc-light passes you while standing still; or if a light-ray from an airplane headlight passes you, seated in another airplane, each plane traveling rectilinearly with uniform velocity at high speed. The inescapable consequence of this principle is that your

watch changes its normal rate of running when the holder of the watch is traveling at speed; and the yardstick you carry changes its length with speed, from its normal length of 36 inches when you are at rest. It is through automatic re-adjustments of your instruments for measuring time and space, in relation to speed of motion, that the velocity of light always turns out to be the same.

2. Second Relativity Principle: Every law of nature with respect to one framework must also hold good for another framework, provided the two frameworks are in uniform movement of translation.

Let us see what this means, by way of illustrations. Suppose a great ocean liner, say the *Normandie*, is steaming along in a straight line without vibration and at a uniform rate of speed. Then all the laws of nature governing velocity, impact, rebound, carom shots, and the like, hold true for a game of billiards played on the ship as for a game of billiards played in a billiard room in a hotel on land. This unchangeability of laws of nature holds good for laws, not only of mechanics, but also of electricity, optics, electrodynamics, etc. To take another example: suppose a man in a motor car travels along a straight road at a uniform rate of speed; and an airplane flies diagonally across the road, traveling in a straight line at a uniform rate of speed. To the man in the motor car, the airplane still appears to be traveling in a straight line at a uniform rate of speed — although this is not the same direction and the same rate of speed as the airplane appears to be traveling, to a stationary observer on the ground. The law of nature, however, remains the same: uniform rectilinear motion.

III

In 1905, in an epochal paper entitled "On the Electrodynamics of Moving Bodies," Einstein derived the fundamental equations for Special Relativity. These equations, algebraic equations involving the space and time units for an inertial system — for instance, the two trains mentioned earlier — are known as the Voigt-Lorentz Transformation. There are certain consequences which flow from these equations: first, there is a certain relation between the units, space and time, of the two moving systems, say the two trains, which is known as the "interval"; and this interval always has the same value in the two systems. Second, there are two quantities, which have the singular property that each quantity in one system is a fixed fraction of a similar quantity in the other system; and lastly, there is a remarkable relationship between the velocities of three trains with known velocities, i.e., the velocity of the second train with respect to the first; of the third train with respect to the second, from which we derive the velocity of the third train with respect to the first. All these quantities differentiate Einstein's Special Relativity equations from Euclid's classical laws of mechanics.

All these quantities have a certain abstractness, which makes it difficult for the beginner to understand them. Persistent efforts have been made for the past 35 years to give a geometrical interpretation of the whole subject and so arrive at greater simplification. Henri Poincaré hit upon one explanation; but as it dealt with rotation through an imaginary angle, which has meaning only for the mathematician, that was really no improvement upon what we already had. Hermann Minkowski suggested classifying all light rays from a point with reference to a cone with vertex at the given point, which he called the "light-cone"; but this was not satisfactory to the physicists, who desired a clearer picture of the optical phenomena involved. Within the past 15 years three new interpretations have been offered: the first by the use of trigonometric functions; the second by the use of hyperbolic functions; and the third by the use of analytic geometry. The first interpretation was by Bertrand Russell, mathematician and philosopher, in 1925; the second by the writer in 1935; and the third, namely the one now under discussion, also by the writer, in 1940. The germ idea of the last interpretation was suggested by a student, C. H. Frick, attending a course in Special Relativity given by the writer in the Summer of 1940.

Russell's and the interpretation of 1935 by the writer required a knowledge of mechanics, and the general laws of motion. The present interpretation requires no knowledge of mechanics; and, as already pointed out above. requires no knowledge of mathematics beyond analytic geometry.

IV

In his famous treatise, "The Mathematical Theory of Relativity," Sir Arthur Stanley Eddington suggested making the unchangeability of the space-time interval the basic postulate of Special Relativity. This is the fundamental feature of the writer's new geometrical interpretation. Let us state the essential problem of Special Relativity in the form of a physical experiment. Imagine a very wide, slightly corrugated, steel belt, moving horozontally with uniform velocity; and a passenger standing on this belt and being carried forward by the belt. Suppose now a motor car runs on to this wide belt and moves with uniform velocity much faster than the belt is moving; and eventually passes the man standing on the moving belt.

Before the experiment begins, the passenger on the belt and the chauffeur regulate their watches so that, at any instant, they record exactly the same time. They also compare the yardstick each one carries with a standard yardstick and find that their yardsticks are exactly 36 inches long. Once the experiment is under way the watches record different times, and the yardsticks record different distances. The problem then is to correlate the measurements the passenger and the chauffeur each makes in space and time with his own yardstick and watch. If we solve the problem, then each man will be able to tell from his own measurements what the other man's measurements will be.

The object of the new geometrical treatment is to draw to scale a chart; and from this chart, by means of a pair of dividers and a graduated ruler, to scale off the required quantities. This chart, as shown in the accompanying illustration, is the essential feature of the new interpretation. This chart may be drawn by means of a device often exhibited in the films in the form of slow motion. We make the second of each man's watch two days, three hours, and forty minutes—a very slow second! The chart shows one hyperbola, five circles, and a number of connecting straight lines.

From the chart we can scale off all the desired quan-

tities needed to afford a complete solution of the problem. To give a single example, we may thus determine the velocity of the motor car with reference to the floor of the building, knowing the velocity of the belt with reference to the floor, and the velocity of the motor car with reference to the belt. The chart enjoys the superiority over ordinary computation which is supplied by a vernier or a slide-rule. It is expected that this new technic for interpreting Einstein's Special Relativity will be incorporated in all future treatises on Relativity. This chart does, both in theory and in practice, really make Relativity easy.

PLATO'S THEORY OF MOTION

Book Notice

PLATO provides an opportunity for the modern mind to get outside its own particular mathematical habit, and to see what are the cosmological notions and ethical standards of a great mind at work without our peculiar modern advantages. In this presentation, Mr. Skemp has analyzed the view Plato took of motion in the later dialogues, especially in that strangest of all of them, Timaeus. The tendency of many modern scholars, Professor Cornford at their head, is to re-evaluate Plato's scientific opinion at a much higher level than heretofore, which means re-translating many passages.

Broadly, this group of men see Plato much more in the way Thomas Taylor did than Jowett did. Mr. Skemp here describes for the Platonist the passages bearing on the relation of cosmic motion to the evolution of the human soul.

The essence of the matter is in the question whether the cosmos is rational and harmonious in its motions; and how does man participate therein? Plato maintains the cosmos (nous) is spherical — what we would call Riemannian — and the human soul derives its harmony from the fact that it is a product of this harmony. Even the body participates in the harmony. "The Parmenidean relation between thought and sphericity which Plato kept to the end, Aristotle abandoned." (p. 83)

These views of Plato are not just guesses made by someone enamoured of half-understood properties of circles and spheres. Mr. Skemp's little book makes it clear that our evaluation of thought in Greece (and that would go for Chaldea and Egypt) is far too low. It is an essential manual for all who can be freshened in our times by the triumphs of other ages. F.K.

THE THEORY OF MOTION IN PLATO'S LATER DIALOGUES, J. B. Skemp. Macmillan, 1942, 123 pages, $2.

TIME AND OPPORTUNITY

For Great Things

"I'd like to see this book read by every *wrong*-thinking American. That's where it would do the most good — in the hands of Americans, for instance, who think that wars 'never settle anything.' And Americans who think that there is nothing wrong with our world except Hitler, Hirohito and Mussolini — and that when these gentry get their trouncing, things are going to be all right again. And Americans who think that their lives can still be lived on the principle that business is business — who believe that 'they are living in a gigantic department store and not on a volcano'." This is what Rex Stout has to say of "A Time for Greatness" by Herbert Agar (N. Y. Times, October 18, 1942).

He goes on — and we agree, "'A Time for Greatness' is a noble, optimistic and inspiring title, but don't be misled by it. Herbert Agar knows that the days have now come which not only try men's souls, but will weigh them in the balance and assay their true worth. This is a time for greatness — if we have the moral guts to rise to greatness. That's the theme of this book. This is a time for greatness only if we learn to see and to meet the great internal, as well as the external challenges to our civilization. That is a man's size job. In fact, it is a 130,000,000 men, women and children's size job. It can be done, according to Herbert Agar, only if we regain our spiritual dignity as Americans, the ethical inwardness of our religious traditions, the political wisdom of the Founding Fathers — in short, the American tradition.

"The reader will find a great deal of wise discussion in this book, of the liberties we cherish and don't always practice, the equalities which we have written into our basic documents and frequently ignore, the fraternities we profess on Sundays and blithely forget the other six days of the week. 'A Time for Greatness' is basically a preachment, by a layman, for laymen. But it is a preachment that goes down easily as you are reading — I for one find extremely palatable such preachments as Agar employs when, describing what we laughingly used to call the post-war period, he writes: 'Men were already retreating from hard facts, such as morals and principles, and giving themselves to airy fantasies, such as "permanent prosperity".'

"It is this return to the hard facts of morals and principles that Herbert Agar cries out for. And he shows, in this book, how they must be applied to our present-day concerns."

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THE GUILD OF AMERICAN ECONOMISTS

A New Principle

THERE IS everywhere a general concern over the choice which appears to confront the country between two unsatisfactory alternatives to solve the problems of distribution of goods and of services, after the war ends. The will to do the right thing is nearly everywhere apparent, and a host of contemporary leaders have given voice to what is nearly a national intent. But what is the right thing? And where is the answer to be found?

Two years of basic study of this issue have been going on quietly, conducted by a group of men associated as the Guild of American Economists, under the general direction of Mr. Norman Dodd of New York City — a task for which Mr. Dodd's wide experience in banking, finance, as these affect government, industry, and the professions, combined with his deep concern for ethical and esthetic values, have eminently equipped him.

The group includes men thoroughly conversant with all the great thinkers in this field — classical, academic and conservative writers in their legion; the rebels and innovators — Silvio Gesell, Karl Marx, Henry George, the Fabians and such as they; social writings both conservative and advanced, done out of anthropological backgrounds by Husserl, Gomperz and others; and its studies have gone back even of these. They have taken account of the talent of all times and places — Manu, Solon, Moses, Plato; the religious sages and the social seers.

Yet notwithstanding deep respect and profound gratitude to all these intellectual and spiritual progenitors of mankind, the Guild felt that a completely new attack on the problem was required, because the problem itself — the mass production potential for security and leisure — is only two generations old however ancient is human nature. Hence from the outset their studies have been governed by the principle of admitting nothing simply on the ground of precedent, and denying nothing simply on the ground of novelty.

Reasonable men no longer doubt that a change must be made from a situation which produced millions of unemployed workers in the richest and most technically equipped country in the world. Reasonable men would also like to start this change before a returning army of disillusioned and disappointed veterans puts an even more critical strain on democracy than occurred in the nineteen-twenties. Yet viewed in the half-light of previously acceptable ideas, the internal alternatives seem to be everywhere the same as those national alternatives which are embodied in the mighty pair of opposites now locked in death struggle on the Russian steppes. Between fascism and socialism, if we are forced to choose between these two, socialism is at any rate in the line of legitimate descent from democracy. On that many American minds are now clear.

But is there no other alternative? Is no third choice possible whereby we can convert our great industrial capacity into an economic system with social objectives? And is there no way to do this without running the risks attendant upon creating a vast bureaucracy which, in the struggle with intransigeance, may after all take a fascist turning? In brief, is there no way to harness the mass production potential so that it shall give freedom and leisure and security to the many, without denying it to the few?

This is the question which the Guild of American Economists posed, as the core of its research proceedings.

Their studies have disclosed such a third possible alternative — one never before considered, consequently never before explored in the history of sociology. Their first conclusions — now in process of formulation — provide for the first time a standard or criterion by which sociology can be converted from a doctrine of idealistic opinion only, which judges and seeks to direct trial-and-error social practices, to an exploratory science based on definite and known law.

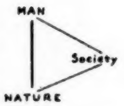
It is not reasonable to suppose that anything so fundamentally new as regards a problem so ancient, can be stated in a few words or understood in a moment. But as henceforth the Social Man section of MAIN CURRENTS will be edited against the background of these newly-found principles, it is necessary to identify them to our readers. Fortunately, like all enduring discoveries, the central ideas are simple. Fortunately also they by-pass completely the veritable jungle of data, pseudo-law, statistics, utopianism and outright fantasy that has obscured economic thought for years.

* * *

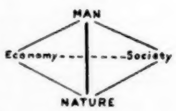
We shall first identify the return to fundamentals which preceded the more detailed studies of the Guild. Two questions were posed: Is the conflict between economic and social forces a natural and necessary state of affairs? How has what appears to be a conflict arisen, in a basic sense? The answers took the following general form; and this provides the new editorial standard for our Social Man section. We recommend these simple considerations to our readers for careful perusal. More will be heard of them.

Man is set off from nature by reason of the occurrence in him of self-consciousness, which no other physical creature possesses.

From this basic fact arises his need for his fellow man, in a form quite different in quality from the herd complex. This need gives rise to human society.



But, equally, the capacity to stand off from Nature gives rise to the power man has to use Nature for his special purposes; whence we get our economy as a second by-product of the basic polarity of man to nature.



From this basic polarity it follows that an opposite and reciprocal relationship of some sort exists between forces created in society by the various forms of man's need for his fellow-men, and forces created by his economic needs — shelter, tools and the like. In a primitive society the opposition of man to nature is not clearly felt, because self-consciousness is naive and all doctrines in the primitive mind are animistic. Also, as proof of the basic theorem that the social and the economic situations

are functions of the man-to-society polarity, we see in primitive society no wide divorcement between social and economic instruments — the fisherman's net is under his roof, his boat is in his village, life is with his family and his clan.

As man's self-consciousness became more and more completely individual he grew farther and farther away from nature; and inevitably his social order grew farther and farther away from his economic order. What has happened in the last century, and especially the acceleration of this divorcement in the final third of that century, is known to all. Today a man of perfectly decent intent and personal kindness can leave a gentle social milieu and, in a few minutes, be operating in an economic fabric with tools and in a manner he can neither justify, or others excuse. The economic instruments he uses in his business office — such as evidences of debt as one example — may deprive many fellow men at distant points of their happiness, even their lives. And he does not find it possible even to explain this state of affairs. All he can do is blame the situation — and others; while these others — society — fight back with political weapons. Civil war is the result.

So far, so good. We now have the basic formula. We proceed with the inquiry. The forces which create society are known, in a general sense, because they are within every individual — need of companionship, sexual and domestic impulses, and the like. They are a compound of factors descending, so to speak, from consciousness and are therefore psychological. But they also ascend, as it were, from material nature, and are thus measurable. The result is human biology; and all the sciences of matter, of life (biology) and of consciousness (psychology) can be brought to bear on understanding the social part of the situation.

What is more for present purposes, scientific social structures can be created and in the case of the United States, have been created. Our tripartite government is the result of the founding fathers' belief in "the laws of nature and of nature's God." Thus, over the ages and culminating in this country, by instinct, intelligence and effort, social laws are themselves expressed on the one side of the economic-social polarity.

But the basic laws on the other, the economic side, have never been sought. Some rule-of-thumb practices exist in economic life, some intuitive artists in business arise. But there are no American studies of economics as an expression of laws arising from nature, below, and fusing with laws projected from consciousness (hence of an ethical character), above, to make a body of economic doctrine which might be equivalent to our socio-political laws, suited to the mass production potential.

Statistical studies abound. Ill-formed political thought exists in the economic domain. In Germany and in Russia necessity has developed some doctrines called laws of enterprise. But the required over-all studies of natural law as manifest in psychology, biology and the physical sciences, and of the manner in which aesthetics and ethics play into the situation, have never been thought of. This job has hitherto never been faced. Facing it involves new and exciting considerations.

Before a professional group of Stewards can be created the curriculum for their training has to be devised, based on a survey of knowledge. The work of the Guild of American Economists encompasses this great project and as the interests of MAIN CURRENTS are to that extent cognate, the Guild's findings as they are formulated will in future constitute the basis for our editorial policy in this Social Man section. F.K.

MAKING A NEW WORLD

Editorial Summary

The Federation of British Industries has issued a pronouncement on Reconstruction; the Association of British Chambers of Commerce one on Post-War Industrial Reconstruction; and the London Chamber of Commerce still another on General Principles of a Post-War Economy. These are evidence of the deep stirrings in British thought.

The editors of *Nature* (Macmillan, London) review these writings in the issue of July 11, 1942, and contrast them with reports from the editors of *Time, Life* and *Fortune*, to the disadvantage of the former. The writer in *Nature* feels that the fair words of the British industrialists are belied by the actual proposals made. "It is left to the American report to correct this false impression of a decadent Britain brooding over the past, and to assess her true contribution to the technique of economic progress. The assumptions on which the American proposal is based are accepted in theory, if not in practice, by all the British reports: that the United Nations will win a complete victory; that the United States will emerge as the strongest single power in the post-war world; and that the least America will settle for is a world in which President Roosevelt's four freedoms are reinforced by a fifth — freedom for individual enterprise. With those assumptions goes the belief that there need be no serious post-war depression, and certainly no unemployment; that there need be no major war for a long time to come; that frontiers can be re-opened; and that there can be room for both democracy and economic freedom — if the United States choose." (p. 34)

Writing on economic subjects is increasingly common in British scientific circles. A great determination has grown up to help to make a better world. *Nature* is especially well-informed and alive to the work to be done. In connection with our references just above to the Guild of American Economists, the issue of *Nature* for January 24, 1942, is especially important. It is devoted to material by Professor George Catlin of Cornell, and Mrs. S. Neville Rolfe, O.B.E., on "The Case for Research in the Social Sciences," and "Biology as a Social Science," respectively (pp. 88-96); also an article by J. A. Crowther of the University of Reading on The Impact of the Physical Sciences on Society (pp. 96-98), one by D. Caradog Jones of the University of Liverpool on Social Science Statistics and Population Problems (pp. 98-100), one by Sir Frederic Kenyon on Ethical and Political Remodelling of Society (pp. 100-101), and one by Alexander Farquharson, General Secretary of the Institute of Sociology, on Research in the History of Sociology (pp. 101-102). This gives some idea of the scale of

inquiry going on in British scientific circles. Nothing anywhere comparable proceeds in scientific groups here.

This makes *Nature's* editorial remarks, in the same issue, highly significant. "The most striking feature of all such developments is, however, the immense amount of *ad hoc* inquiry, investigation and research which is still required over the whole range of the social sciences as a basis for policy and action. It is this that raises such studies to the priority level even in war-time, if having won the War we are not once again to lose the Peace." We would add: inquiry into the whole fabric of scientific thinking is also involved in good planning.

THE ARCHBISHOP OF CANTERBURY On Christian Economics

"The Archbishop of Canterbury, speaking before 6,000 persons in Albert Hall, condemned modern society's emphasis on the profit motive and advocated a limiting of bank credit to the amount deposited by clients and declared that further credit should be a function of public authority. Sir Stafford Cripps, Lord Privy Seal, who also addressed the mass meeting, organized by the Industrial Christian Fellowship, urged the church to undertake here and now its task of social salvation. The Archbishop of York advocated a central planning authority through which the State would develop land in the interests of the public. Sir Stafford urged the church to adopt the five simple desires of the American people as expressed by President Roosevelt. These are, he said, equality of opportunity, jobs for those who can work, security, the ending of privilege, and civil liberty. The function of the church, he declared, is not to enter the political lists but to provide the moral force and driving power for social and economic development. If privilege is ended in Britain, he warned, we must be prepared to give up our privileges with the rest, not excluding the privilege of endowment and the establishment of the church." (*New York Times*, September 26, 1942. Following is the full text of the Archbishop of Canterbury as made public by the British Information Services. It is important to readers of MAIN CURRENTS to have on record great pronouncements such as these. F.K.

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THE Church has both the right and the duty to declare the principles which should govern the ordering of society. It has this right because, in the revelation entrusted to it, it has the knowledge concerning man and his destiny which depends on that revelation and which illuminates all questions of human conduct.

Of course, it is universally recognized that the Church should lay down principles for the conduct of individuals.

What lately is being disputed is the right of the Church also to lay down principles for the action of corporate groups, such as trade unions, employers' federations, or national States, or to undertake in any way the direct ordering of men's corporate life.

This distinction between individuals and the various groupings in which the lives of individuals are conducted is quite untenable. The whole life of man is conducted in societies. Those societies will, in structure and in function, express the character of those who compose the society and the aims which they have set before themselves. And these, having been expressed in the structure of society, will be reproduced through a process of constant unconscious suggestion in every new generation.

The understanding which the church has concerning the nature of the destiny of man gives it the qualifications for declaring what kind of structure in society is wholesome for man and what is unwholesome.

Prejudice against this arises from the risk that Christian people may attempt to impose upon a society consisting of people who are very mixed in religious allegiance a type of order that will only work effectively if all the citizens are genuine Christians. But that is a snare which Christians engaged in this enterprise ought easily to avoid, for it is a fundamental part of the whole Christian conception of man that unless he is guided by trusting in the grace of God, he is incapable of conducting his life in accordance with the pattern of divine intention.

Nevertheless, there are certain ways of ordering society which express and reproduce a definitely unwholesome outlook on life and others which suggest a right ordering of human motives — and between the two the church is qualified to judge.

But the church has not only the right but it has the duty to declare the principles of the true social life.

This is not a duty first and foremost to society and does not arise from the fact that men have the right to claim guidance from it; it is first and foremost a duty to God and arises from the obligation to bear witness to the fullness of the gospel and the blessings for human life which that contains.

It would not be possible, as an introduction to a discourse like this, to set forth the social principles that Christianity undoubtedly involves. That task has been performed many times and in this audience the general upshot may be assumed. When we look upon the society with which we have been familiar, two points in its ordering at least challenge the judgment of the Church which must inevitably be uttered in condemnation.

The first is the broken fellowship in our society — which Disraeli called the two nations. For the moment, no doubt, under the stress of war, our whole people are united, but we know quite well that it was not so in the days of peace and that, when the special urgency of war is past, the seeds of old divisions will spring up, and bear their fruit again unless steps are taken to recreate fellowship.

Our Lord told us plainly that if we would seek first His Kingdom of Justice, material goods would be added to us according to our need — that is manifestly true. If every man were eager that all his fellow-citizens should have enough before he himself had any superfluity, there can be no doubt that all would have enough.

But we do not put first God's Kingdom of Justice and we each seek our own advantage, checking the competition which results only at the point where it threatens our mutual destruction.

St. Paul rather surprises us, until we think carefully, when among the works of the flesh, he puts alongside

of obvious carnal indulgences, envyings, strife, seditions, and so forth.

But by "the flesh" he means the outlook upon life which primarily is concerned with material goods; of these, so far as they are purely material, it is true to say that the more one has, the less there is for others, so that each man's success represents corresponding failure in his neighbors. Whereas, of the fruits of the spirit, it is true that the more one man has, the more the others have on that account alone; that is true of knowledge, appreciation of beauty, courage, love, joy and peace.

These things are not limited in amount, so that if one has more, there is less for others, but they are infectious, and wherever they are found in one human being, they are found also to some extent in all with whom he consorts. So that to care first for these things is always the way of fellowship.

The broken fellowship of our society rests upon the materialism of our habitual outlook. This leads to that gross disparity of wealth and poverty which must at all costs be remedied. It leads also to a lack of leisure which, in an age of mechanized industry, involves a lack of opportunity for a fully human life. To provide for all adequate leisure, with the means to utilize and enjoy it, must be one of our primary aims.

The other point to which I wish to allude is another expression of this principle. The predominant motive, guiding not only enterprise but the whole ordering of industry, has been what is commonly called the profit motive. Now it is true that we are constantly told there is no harm in a man's seeking to better his position and to gain for his children a fuller life than has been possible for himself, provided that this is secondary and not primary in his mind.

The profit motive is not simply evil, it can have its own right place. But that is not the first place, and the harm in the predominance of the profit motive is not merely that it is an expression of selfishness, whether the form it takes is concerned with dividends or wages, but that to put this first may lead to an ordering of economic life which in fact is damaging to the general interest.

An obvious illustration is afforded by the whole question of the location of industry. If this is to be ordered with reference to the general welfare and proper balance of agriculture and other industries, then concern for profit from the industry itself, whether dividends or wages, must take second place.

But how are we to secure that it takes second place if the people who have to make the decision are in fact bound together only by concern for the efficiency of the enterprise they conduct and are not selected, and made formally responsible, for their contribution to the general good?

However high-minded the directors of a privately owned concern, they are not called upon, and probably have not the qualifications, to decide what is most in the public interest, and it is absurd to expect that they will order that part of the national life which has been entrusted to them with a view to something for which they were not selected and are probably unqualified to estimate with full knowledge.

We have to find a way of securing that the general interest in which we are all united takes precedence over every sectional interest by which we may be divided.

For the promotion of that general interest there are two special problems which we need to consider with an altogether new thoroughness. These are land and money.

There are four requisites for life which are provided by nature, even apart from man's labor; air, light, land and water. I suppose if it were possible to establish a property claim upon air somebody would have done it by now and would have made people pay if they wanted to breathe what he would then call his air. So too of light. But it has not been found possible to do this.

Unhappily, it has been found possible in the case both of land and water, and we have tended to respect claims made by owners of land, and water flowing through or beneath it, in a way which subordinates the general interest to the private interest of those owners. I am not persuaded that the right way to deal with this question is by nationalization of land, but I am sure we need to assert the prior interest of the community respecting land and water with a vigor of which recent political history shows no trace.

Here, supremely, the principle of the old Christian tradition holds good that the right of property is the right of administration or stewardship — never the right of exclusive use.

The present treatment of land and the buildings placed on it strikes me as perfectly topsy-turvy. If a landlord neglects his property and it falls into a bad condition, which is an injury to society, the rates upon that property are reduced, while if he improves the property, and so does a service to society, his rates are increased. But if the rates were levied on the land itself, not on the buildings placed on it, there would always be an inducement to make the property as good as possible in order that the best return might be received from it.

I think we should welcome the proposals of the Uthwatt Report. They aim at a combination of the advantages of public ownership and ultimate control with private initiative. But we must see they are not whittled down by concessions to vested interests.

You see I am going on the supposition that what we have to do is not to expect that men will guide their conduct always by the motive of service instead of self-interest, but rather so to organize life that self-interest prompts those actions which are of greatest social service.

In the case of money, we are dealing with something which is handled in our generation by methods that are extremely different from those in vogue a century or half a century ago. When there was a multitude of private banks, the system by which credit was issued may perhaps have been appropriate, but with the amalgamation of the banks, we have now reached the stage where something universally needed — namely money, or credit which does duty for money — is become in effect a monopoly.

It seems to me a primary political principle that wherever you have something which is universally needed, but which is governed as a monopoly, that monopoly should be taken over by the State. The private issue of new credit should be regarded in the modern world in just the same way in which the private minting

of money was regarded in earlier times. The banks should be limited in their lending power to the amount deposited by their clients, while the issue of newer-credit should be the function of public authority.

This is not in any way to censure the banks or bankers. They have administered the system entrusted to them with singular uprightness and ability and public spirit. But the system has become anomalous, and, as so often happens when an anomaly has persisted through a long period of time, the result is to make into the master what ought to be the servant.

But that leads me to my last point. Whatever you may have thought of my earlier points, this at least is one which is the Church's direct concern. When all is said, the trouble with our social life is sin — that strange perversion and fatality of human nature as a result of which, if we are not guided by trusting to the grace of God, we convert our very blessings into curses.

Let us never suppose that by any external re-arrangement of the ordering of life we can establish either justice or good-will. Sin, which now expresses itself in an unlimited acquisitiveness for wealth, can just as easily express itself in grasping and manipulating the levers of power in a collectivized society.

It is true that some orderings of society seem to suggest and encourage self-seeking, while others suggest and encourage fellowship, but even the latter can be perverted by the sin and selfishness of men, and the primary duty of the Church in the social field is to call her citizens to recognize that civic no less than individual action stands under the judgment of God; that they are responsible to Him for it, and that it can truly prosper only if they submit social, as personal, life to the redeeming love of God in Christ.

To do this, we must relate our social life to worship, and worship to our social life. We must appreciate afresh the meaning of the Eucharist where we offer to God the fruit of man's labor exercised upon God's gifts of bread and wine, representing all economic wealth, that we may receive it back from Him, charged with His own grace and power and shared in perfect fellowship.

Our highest act of worship is the symbol of the truly Christian social order. But we have been blind to that aspect of it and need to recover our sensitiveness. When worship is once more the consecration of life, and all life — industry and commerce, no less than friendship and the family — is the corollary of worship, our church will again truly live and society will be the fulfillment of our dreams.

One danger is here, very insidious, which must be warded off. It is that we shall try to make God the means to our ends, the instrument of our plans. That is sheer disaster. We dedicate ourselves to this enterprise in His name, believing it to be His will, in the hope that through it He may be glorified in drawing the people into that fellowship which is the counterpart of His holy love.

AN INTERNATIONAL UNIVERSITY Proposed by Bertrand Russell

Present-day education, controlled as it is by national states, inevitably promotes a certain degree of nationalism entirely out of harmony with any idea of international government. In the totalitarian countries especially, education has been used as a preparation for war just as surely as has the manufacture of munitions; under international authority this "ideological preparation for rebellion" would be forbidden. The narrowness of the aims and the false beliefs instilled by bad education show that national education should be subject to international control. The positive aims of this system would be to give instruction free from any national bias, to train teachers for this work, and to produce "text-books and works of research calculated to encourage a universal human loyalty rather than a sectional devotion" to any part of the human race.

Academically superior to any existing university and diffusing an outlook calculated to prevent future wars, an international university located in some neutral territory would be the central institution in such a plan. It should have a Bill of Rights and must be open to "all races, all religions, all political opinions except such as reject the idea of an international government." The teaching staff, selected equally from among the most eminent and well qualified men of different nationalities, would be represented in the governing body of the University together with a number of men chosen by the international authority because of their administrative ability, or to give adequate representation to the various nations.

An entirely post-graduate student body would eliminate any idea of competition with existing Universities. Among the advantages would be fellowships offered to older men, visiting lecturers supplementing the permanent staff, and summer schools. Science would be emphasized in the curriculum, and with peace made more secure, humane and public-spirited men would be assured that their inventions would not be used to make war more terrible. The mixture of nationalities would tend to diminish national bias, and subjects such as history would be taught without any distortion of facts in an attempt to make one particular nation seem more admirable.

In the matter of text-books a licensing board should be appointed by the international University to select from books already written or to commission the writing of new ones. These internationally authorized text-books would be used by the separate states in their educational systems, not to prevent students from encountering different points of view but to give them a sure factual basis from which they might go on to read propaganda of all sides without being misled.

Just as in the past the internal stability of the national governments of large countries has been guaranteed by educational propaganda so, if a Federation powerful enough to prevent future world wars is to be established, the outlook and education of the people must be geared accordingly.

The new hope which will thus be afforded men of vision will liberate their creativeness and will bring forth a great age, "in which a new productiveness will be generated by new hopes and wider loyalties." (The Fortnightly, July, 1942. Pp. 8-16. Abstract by G.B.)